



1754

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Patent Application of :
NOLAN et al. : METHOD FOR CONTROLLING
Filed: December 5, 2000 : ELEMENTAL MERCURY
Serial No.: 09/730,100 : EMISSIONS
Art Unit: 1754 :
Examiner: Anthony J. Kuhar : (Case 6121)
Commissioner for Patents
P.O. Box 1450
Arlington, VA 22313

INFORMATION DISCLOSURE STATEMENT (IDS)
AND SUPPLEMENTAL REMARKS

Sir:

Applicants under the provisions of 37 CFR §§1.56, 1.97 and 1.98 call the Examiner's attention to the references listed on the enclosed Form PTO/SB/08. A copy of each not stricken-through reference listed is enclosed. The Commissioner is hereby authorized to charge the \$180.00 fee required under 37 CFR §1.17(p) for consideration of this IDS to Deposit Account No. 50-1807.

In submitting this IDS, the Examiner is also requested to consider the following Supplemental Remarks along with the Amendment previously filed by Applicants via facsimile transmission on September 30, 2003. Given the relatively short period of time between the previous amendment and the present date, entry of these Supplemental Remarks is believed to be proper pursuant to MPEP §714.03(a).

Consistent with that September 30th amendment, Applicants reiterate that their invention allows for the in situ removal of mercury, in an existing wet scrubber apparatus, through the use of an oxidizing agent and a sulfide species in the presence of an aqueous alkali scrubbing liquor, in a manner that was not previously taught or suggested by the prior art. Applicants alone realized that, through the separate addition and mixing of these reactants and the creation of a gas-liquid interface within the confines of the wet scrubber, it was possible to remove mercury from a flue gas without substantially modifying the existing wet scrubber equipment and without having to separately draw the scrubbing liquor out of the wet scrubber in order to subsequently precipitate the mercury removed during the process out of the liquor.

Understanding that the enclosed IDS contains a substantial number of references, the Examiner is respectfully requested to pay particular attention to reference #116, WO 98/16301 (hereafter "WO 301"). The Examiner will note that cite No. 118, US 6,284,208 B1 to Thomassen, also corresponds to this WO 301. This reference describes a mercury removal scheme wherein washing water containing an oxidizing agent is co-currently fed into the flue gas. Notably, WO 301 teaches that the specific amount of oxidizing agent added to the water is dictated by a range of redox potentials. The flue gas-wash water mix is then turbulently mixed over a consumable bed of solid limestone. During this process, the mercury within the flue gas is oxidized to a soluble form and then subsequently precipitated as HgS when the soluble mercury comes into contact with sulfur dioxide present in the flue gas.

Significantly, WO 301 does not call for the deliberate addition of sulfide species to the flue gas. Instead, WO 301 seems to rely solely upon the sulfur dioxide already present in the flue gas, and the overall mercury removal capabilities enumerated in that reference appear to suffer as a result (see page 4, lines 7-8, wherein the final mercury concentration of flue gas purified by the process is between 11 and 16 micrograms per normal cubic meter). In fact, it is respectfully submitted that one skilled in the art would consider it counter-intuitive to deliberately add sulfide species to a process which is, itself, intended to remove sulfur species from the flue gas.

Equally important, as described at page 9, lines 7-12 of the reference, the limestone or other carbonate medium must have a low solubility in hot water; therefore, the washing water utilized in this reference will not contain any carbonates or other aqueous alkali reagents. In fact, WO 301 utilizes a solid carbonate or limestone bed in place of an aqueous alkali scrubbing liquor. The reference goes on to teach that the required solid should have the added benefit of acting as a turbulent mixer (see Page 1, lines 21-25). Finally, it is worthy to note that an implicit drawback inherent in this method is that the consumable solid limestone bed must be monitored and eventually replaced.

Yet another salient point of this reference deals with the manner in which the reactants are introduced into the solid carbonate bed. In particular, this reference emphasizes the need to conduct add washing solution in a manner which is co-current to the flow of the flue gas so as to avoid the need for drop-catchers and similar apparatus (see Page 2, line 30 through Page 3, line 4 and/or Page 7, lines 28-35). Thus, this reference appear to teach that any sort of liquid entrainment, while

necessary to oxidize the mercury into a soluble form, is inherently undesirable and can be controlled through a counter-current arrangement which brings the flue gas into close proximity with the spent scrubbing liquor accumulated at the bottom of the apparatus.

Given the above, the amended claims of the present invention are patentably distinguishable from WO 301 on several counts. First, it must be noted that WO 301 does not contemplate the specific addition of sulfides to insure complete and total mercury removal; consequently, the mercury removal capabilities of that reference (down to 11-16 micrograms per normal cubic meter, see page 4, lines 7-8) suffer in comparison to the present invention. Moreover, to the extent that the present invention provides aqueous alkali scrubbing liquor and relies upon the creation of a gas-liquid interface to achieve its desired mercury removal, the requirement for a solid carbonate bed in WO 301 actually teaches away from the feasibility of the present invention. Finally, all of the arrangements pictured in the present application depict counter-current scrubbers, whereas WO 301 characterizes such an arrangement as undesirable and, instead, states that co-current mixing of the wash water and flue gas are required (resulting in substantially different structure). Thus, WO 301 does not teach or suggest the amended claims because of differences in provision of the alkali reactant, the means by which the flue gas is mixed with those reactants and by the fact that WO 301 fails to explore the seemingly counter-intuitive notion of adding sulfide species to a process explicitly designed to remove sulfur and mercury from a flue gas.

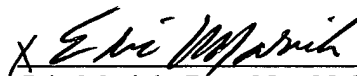
A careful examination of the details of WO 301 reveals that the inventors alone identified several significant aspects of a novel process--including the use of aqueous alkali scrubbing liquors within existing wet scrubber installations, the creation of a gas-liquid interface and the use of oxidizing agents and additional sulfide species--in order to craft a process which removes mercury from flue gases to a level that was previously not contemplated by the art. Moreover, all of the arrangements pictured in the present application depict counter-current scrubbers, whereas WO 301 characterizes such an arrangement as undesirable and, instead, states that co-current mixing of the wash water and flue gas is required (thereby requiring different structures to carry out the process of WO 301). Finally, given the inherently unpredictable nature of chemical reactions--a point readily appreciated by those skilled in art--the implicit and explicit teachings of WO 301, along with many of the other references cited in the IDS, seem to teach away from the claims of the present invention. For example, insofar as the method requires insoluble solid carbonates, one skilled in the art would

not expect to be able to substitute soluble carbonates into that method without first expending significant, inventive efforts in order to adequately effect such a substitution. Similarly, the absence of any suggestion to add sulfides, especially in a process which is specifically designed to remove sulfur dioxide (such as WO 301), would indicate that application of that reference to the amended claims of the present invention is not appropriate. In short, to the extent that Applicants alone realized (and now claim) that the addition of sulfides and oxidizing agents could achieve superior results, especially to the extent that the addition of these reactants must be conducted separately but in the presence of the aqueous alkali scrubbing liquor in a wet scrubber which itself promotes the formation of a gas-liquid interface between the reactants. This significant discovery is neither taught nor suggested by WO 301.

Notwithstanding the fact that remarks above are directed specifically to the WO 301 reference, the Examiner is requested to carefully consider these remarks with respect to each and every reference contained in this IDS and in conjunction with and in addition to those references previously noted in the record. Upon doing so and upon further consideration of the previously submitted Amendment dated September 30, 2003, Applicants believe the case is now in condition for allowance and such action is hereby requested.

The Examiner is respectfully requested to consider the references submitted herewith, together with such other relevant materials the Examiner locates as a result of an independent search, in the examination of the present patent application.

Respectfully submitted,



Eric Marich, Reg. No. 32,265

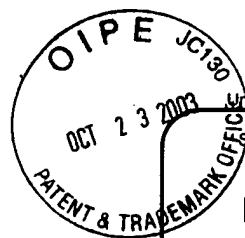
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First Named Inventor	Nolan
Art Unit	1754
Examiner Name	Anthony J. Kuhar
Attorney Docket Number	6121

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U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
	1	US- 3,855,387	12/17/1974	Brockmiller et al.	Ab, C2, L65 - C3, L20
	2	US- 3,892,837	07/01/1975	Uchiyama et al.	C6-7
	3	US- 3,981,972	09/21/1976	Hishinuma et al.	Ab, C3-4
	4	US- 4,094,879	06/13/1978	Bates et al.	Ab
	5	US- 4,098,697	07/04/1978	DeAngelis et al.	Ab, C2, L60, C3, L60
	6	US- 4,190,709	02/26/1980	Hodgkin	Ab
	7	US- 4,230,183	10/28/1980	Kalfoglou	Ab
	8	US- 4,273,747	06/16/1981	Rasmussen	Ab, C3-4
	9	US- 4,283,303	08/11/1981	Ellis	Ab
	10	US- 4,285,819	08/25/1981	Yen et al.	Ab
	11	US- 4,377,484	03/22/1983	Nasrallah	Ab, C6
	12	US- 4,578,195	03/25/1986	Moore et al.	Ab, C6
	13	US- 4,857,183	08/15/1989	Boomer	Ab
	14	US- 4,889,698	12/26/1989	Moller et al.	Ab, C3-7
	15	US- 4,889,701	12/26/1989	Jones et al.	Ab, C4, 7, 8
	16	US- 4,975,264	12/04/1990	Franken	Ab, C3, 4
	17	US- 5,139,982	08/18/1992	Ayala et al.	Ab
	18	US- 5,168,065	12/01/1992	Jankura et al.	Ab, C2-4
	19	US- 5,238,665	08/24/1993	Lerner	Ab, C4

FOREIGN PATENT DOCUMENTS

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		Country Code ³ *Number ⁴ *Kind Code ⁵ (if known)				
	80	JP-64-557-B	06/22/1974	Nippon Mining	Ab	
	85A	EP-0709128-A	06/01/1986	Kubisa et al.		
	86	DE-19731162-A	01/28/1999	Holste et al.		
	88	EP-0294658	12/14/1988	Ebara Corp.	Ab, Fig 1	
	89	JP-06296825	10/25/1994	Ebara Corp.	Ab, Claim 1	✓
	90	JP-07299328	11/14/1995	Metallgesellschaft	Ab, Claim 1, P2	✓

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Sheet

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		Number-Kind Code ² (if known)			
	20	US- 5,246,471	09/21/1993	Bhat et al.	C2-3
	21	US- 5,308,509	05/03/1994	Bhat et al.	C2
	22	US- 5,354,363	10/11/1994	Brown, Jr. et al.	Ab
	23	US- 5,357,002	10/18/1994	Lezzi et al.	Ab
	24	US- 5,372,940	12/13/1994	Sakamoto et al.	Ab
	25	US- 5,380,747	01/10/1995	Medford et al.	
	26	US- 5,405,593	04/11/1995	Knudson	Ab
	27	US- 5,428,154	06/27/1995	Gansow et al.	
	28	US- 5,459,276	10/17/1995	Kuhn et al.	Ab
	29	US- 5,459,040	10/17/1995	Hammock et al.	Ab
	30	US- 5,500,196	03/19/1996	Rogers et al.	Ab, C1-2
	31	US- 5,520,897	05/28/1996	Rogers et al.	Ab, C1-2
	32	US- 5,564,105	10/08/1996	Alvino et al.	Ab, C2-3
	33	US- 5,622,996	04/22/1997	Fish	Ab
	34	US- 5,672,323	09/30/1997	Bhat et al.	Ab, C1-2
	35	US- 5,750,351	05/12/1998	Medford et al.	
	36	US- 5,773,209	06/30/1998	Medford et al.	
	37	US- 5,773,231	06/30/1998	Medford et al.	
	38	US- 5,783,596	07/21/1998	Medford et al.	

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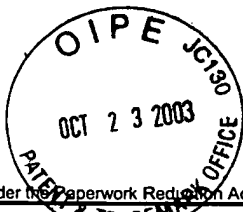
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		Country Code ³ -Number ⁴ -Kind Code ⁵ (if known)				
	91	JP10249154	09/22/1998	Kawasaki Heavy	Ab	<input checked="" type="checkbox"/>
	92	JP62186925	08/15/1987	Mitsubishi Heavy	Ab	<input type="checkbox"/>
	94	JP57007232	01/14/1982	Tohonen KK	Ab	<input type="checkbox"/>
	100	JP6245325	02/27/1987	Mitsubishi Heavy	Ab, P1, 4	<input checked="" type="checkbox"/>
	101	JP5023540	02/02/1993	Yoshikubo et al	Ab	<input type="checkbox"/>
	102	CA2158671	07/31/2001	Sitges	Ab, P2, 3	<input type="checkbox"/>

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	39	US- 5,785,735	07/28/1998	Raskin et al.	Ab
	40	US- 5,792,787	08/11/1998	Medford et al.	
	41	US- 5,795,548	08/18/1998	Madden et al.	Ab, C4-5
	42	US- 5,807,884	09/15/1998	Medford et al.	
	43	US- 5,809,693	09/22/1998	Chet et al.	Ab
	44	US- 5,811,449	09/22/1998	Medford et al.	
	45	US- 5,814,288	09/29/1998	Madden et al.	Ab C1-5
	46	US- 5,814,591	09/29/1998	Mills et al.	Ab
	47	US- 5,821,260	10/13/1998	Medford et al.	
	48	US- 5,827,352	10/27/1998	Altman et al.	Ab C3-6
	49	US- 5,834,525	11/10/1998	Fish	Ab
	50	US- 5,846,959	12/08/1998	Medford et al.	
	77	US- 1,897,921	02/14/1933	Bacon	Figs P1-2
	78	US- 3,331,732	07/18/1967	Venemark	C1-2
	79	US- 5,599,508	02/04/1997	Martinelli et al.	Ab C2-4
	81	US- 6,284,100	09/04/2001	Downs et al.	
	82	US- 6,503,470	01/07/2003	Nolan et al.	Entire Doc
	83	US- 3,817,713	06/18/1974	Ionescu	Entire Doc
	84	US- 4,044,098	08/23/1977	Miller et al.	Ab, C2-3

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		Country Code ³ -Number ⁴ -Kind Code ⁵ (if known)				
	104	DE-4105058-A1	08/20/1992	Ahrens-Botzong		
	105	EP-02078537-A2	01/09/1987	Norddeutsche		
	106	WO-97/19670	06/05/1997	Hedner et al.	Ab	
	107	DE-3702463-A1	08/18/1988	Holter et al.		
	115	WO-99/58228	11/18/1999	ISCA Management LTD		
	116	WO-98/16301	04/23/1998	Thomassen	Ab, P1-4 & P7,9	

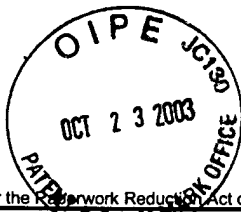
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	87	US- 6,372,187	04/16/2002	Madden et al.	Ab, C2
	93	US- 5,419,834	05/30/1995	Straten	Ab, Fig 4 C1-3
	98	US- 6,214,304	04/10/2001	Rosenthal et al.	
	99	US- 6,328,939	12/11/2001	Amrhein	Entire Doc
	103	US- 4,820,391	04/11/1989	Walker	Ab, C2-3
	108	US- 4,443,417	04/17/1984	Wiklund	
	109	US- 4,729,882	03/08/1988	Ide et al.	Ab, C3-4, 7-10
	110	US- 4,233,274	11/11/1980	Allgulin	
	111	US- 5,008,871	04/23/1991	Higuchi et al.	
	112	US- 6,447,740	09/11/2002	Caldwell et al.	
	118	US- 6,284,208	09/04/2001	Thomassen	See Cite 116
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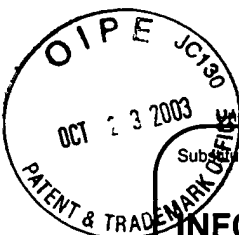
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	117	JP-52023862	02/23/1977	Takeda Chem Ind. Ltd	Ab	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Compleat if Known

Application Number	09/730,100
Filing Date	December 5, 2000
First Named Inventor	Nolan
Art Unit	1754
Examiner Name	Anthony J. Kuhar
Attorney Docket Number	6121

Sheet 1 of 3

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Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
	51	VIDIC, R.D. ET AL., "Uptake of Elemental Mercury Vapors by Activated Carbons," Journal of the Air and Waste Management Association, March 1996, pgs 241-250 V46.	
	52	NOBLETT, JR. ET AL., "Control of Air Toxics from Coal-Fired Power Plants Using FPG Technology," July 1993, 15 pages, presented at RPRI Second International Conference on Managing Hazardous Air Pollutants, Washington, DC.	
	53	CHANG, R. ET AL., "Developing Mercury Removal Methods for Power Plants," EPRI Journal, July/August 1994, pgs 46-49.	
	54	FELSVANG, K. ET AL., "Air Toxics Control by Spray Dryer Absorption Systems," November 1992, pgs V1-1-V1-17, presented at Power-Gen '92, Orlando, FL.	
	55	CHANG, R. ET AL., "Mercury Emission Control Technologies: An EPRI Synopsis," Power Engineering, November 1995, pgs 51-57.	
	56	"Emission Factors Handbook: Guidelines for Estimating Trace Substance Emissions from Fossil Fuel Steam Electric Plants," November 1995, pages: Cover, Report Summary, 2, 2-11, 2-12 & 2-13, EPRI, TR-105611s.	
	57	"Properties of EDTA, DTPA, HEDTA, and NTA", 1974, 2 pages, advertisement by The Dow Chemical Company.	
	58	HALL, E.H., "Mercury Emissions and Controls," Status Report from Battelle Memorial Institute, May 1, 1994, 94TEC-1, 49 pages, Columbus, OH.	
	59	MEU, R., "The Fate of Mercury in Coal-Fired Power Plants and the Influence of Wet Flue-Gas Desulphurization," Water, Air and Soil Pollution, 1991, pgs 21-29, 56:21-33.	
	60	GLEISER, R. ET AL., "Mercury Emission Reduction Using Activated Carbon with Spray Dryer Flue Gas Desulfurization," April 25-27, 1994, pgs 452-457, presented at the 36th Annual Meeting American Power Conference, Chicago, IL.	

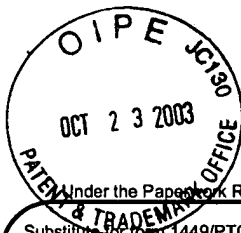
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Attorney Docket Number	6121

Sheet	2	of	3
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	61	GLEISER, R. ET AL., "Control of Mercury from MSW Combustors by Spray Dryer Absorption Systems and Activated Carbon Injection," 1993, pgs 106-122, MSW Conference Proceedings, Williamsburg, VA.	
	62	PETERSON, J., "Mercury Removal by Wet Limestone FGD Systems: EPRI HSTC Test Results (94-RP114B.01)," June 19-24, 1994, pgs 1-16, presented at the 87th Annual Meeting & Exhibition of Air & Waste Management Association, Cincinnati, OH.	
	63	CHANG, R. ET AL., "Pilot Scale Evaluation of Activated Carbon for the Removal of Mercury at Coal-Fired Utility Power Plants," July 13-15, 1993, pgs 1-17, presented at the 2nd International Hazard Pollution Management, Washington, DC.	
	64	GULLETT, B.K., ET AL., "Bench-Scale Sorption and Desorption of Mercury with Activated Carbon," March 30-April 2, 1993, 8 pages presented at the International Conference MWC, Williamsburg, VA.	
	65	LICATA, A. ET AL., "An Economic Alternative to Controlling Acid Gases, Mercury and Dioxin from MWCs (94-MP17.06)," June 19-24, 1994, pgs 1-21, presented at the 87th Annual Meeting & Exhibition for Air & Waste Management Association, Cincinnati, OH.	
	66	CHANG, R., ET AL., "Sorbent Injection for Flue Gas Mercury Control (94-WA68A)," June 1994, 13 pages, presented at the Air & Waste Management Association Conference, Cincinnati, OH.	
	67	JONES, C., "Consensus on Air Toxics Eludes Industry to Date," Power, October, 1994, pgs 51-52, 55-56 & 58-59.	
	68	MORENCY, J.R., "Control of Mercury in Fossil Fuel-Fired Power Generation," July 21, 1994, pgs 1-7, presented at DOE Contractors Meeting, Pittsburgh, PA.	
	69	Steam/its generation and use, 40th Edition, 1992, pgs: Cover, ii, 35-1 - 35-16, The Babcock & Wilcox Company.	
	70	REDINGER, K.E. ET AL., "Mercury Emissions Control in RGD Systems," August 25-29, 1997, 17 pages, presented at the EPRI/DOE/EPA Combined Utility Air Pollutant Control Symposium, Washington, DC.	

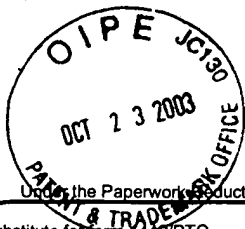
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

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Completion if Known

Application Number	09/730,100
Filing Date	December 5, 2000
First Named Inventor	Nolan
Art Unit	1754
Examiner Name	Anthony J. Kuhar
Attorney Docket Number	6121

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	71	HOLMES, M.J. ET AL., "Advanced Emissions Control Development Program," July 21-23, 1998, 16 pages, presented at the Advanced Coal-Based Power and Environmental Systems '98 Conference, Morgantown, WV.	
	72	FARTHING, G.A. ET AL., "B&W's Advanced Emissions Control Development Program," March 20-23, 1995, 12 pages, presented at the 20th International Technical Conference on Coal Utilization & Fuel Systems, Clearwater, FL.	
	73	REDINGER, K.E. ET AL., "Mercury Speciation and Emissions Control in FGD Systems," March 17-20, 1997, presented at the 22nd International Technical Conference on Coal Utilization & Fuel Systems, Clearwater, FL.	
	74	HOLMES, M.J. ET AL., "Control of Mercury in Conventional Flue Gas Emissions Control Systems," November 12-14, 1997, 17 pages, presented at the Managing Hazardous Air Pollutants Conference, Washington, DC.	
	76	LIVENGGOOD ET AL., "Improved Mercury Control in Wet Scrubbing Through Modified Speciation," August 25-29, 1997, 16 pages, presented at the EPRI/DOE/EPA Combined Utility Air Pollutant Control Symposium, Washington, DC.	
	95	J. Phys. Chem. Ref. Data, 1985, pgs 803-806, Vol. 14, Suppl. 1, JANAF (Joint Army, Navy & Air Force) Thermochemical Tables.	
	96	J. Phys. Chem. Ref. Data, December 31, 1961, 2 pages, 2nd Edition, JANAF (Joint Army, Navy & Air Force) Thermochemical Tables.	
	97	Handbook of Chemistry and Physics, 1976-1977, pg B-131, 57th Edition, CRC.	
	114	Zhao, L. et al., "Mercury Absorption in Aqueous Hypochlorite," Aug. 1999-	
	75	REDINGER, K.E. ET AL., "Mercury Emissions Control in RGD Systems," August 25-29, 1997, 17 pages, presented at the EPRI/DOE/EPA Combined Utility Air Pollutant Control Symposium, Washington, DC.	

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